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Associated Health Benefits on Mortality of Reducing Particulate Matter (PM2.5) in Spain

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Introduction: SERCA Project

- The study was carried out in the framework of the Air Pollution Risk Assessment System (**SERCA**)

- 3-year project (2009-2011)

- Spanish network of environmental and public-health professionals
  - Coordinator: Laboratory of Environmental Modelling. Technical University of Madrid (UPM)
  - Institute of Environmental Assement and Water Research (IDAEA-CSIC)
  - National Center for Epidemiology (ISCIII)

Introduction: background and objective

- **Background**

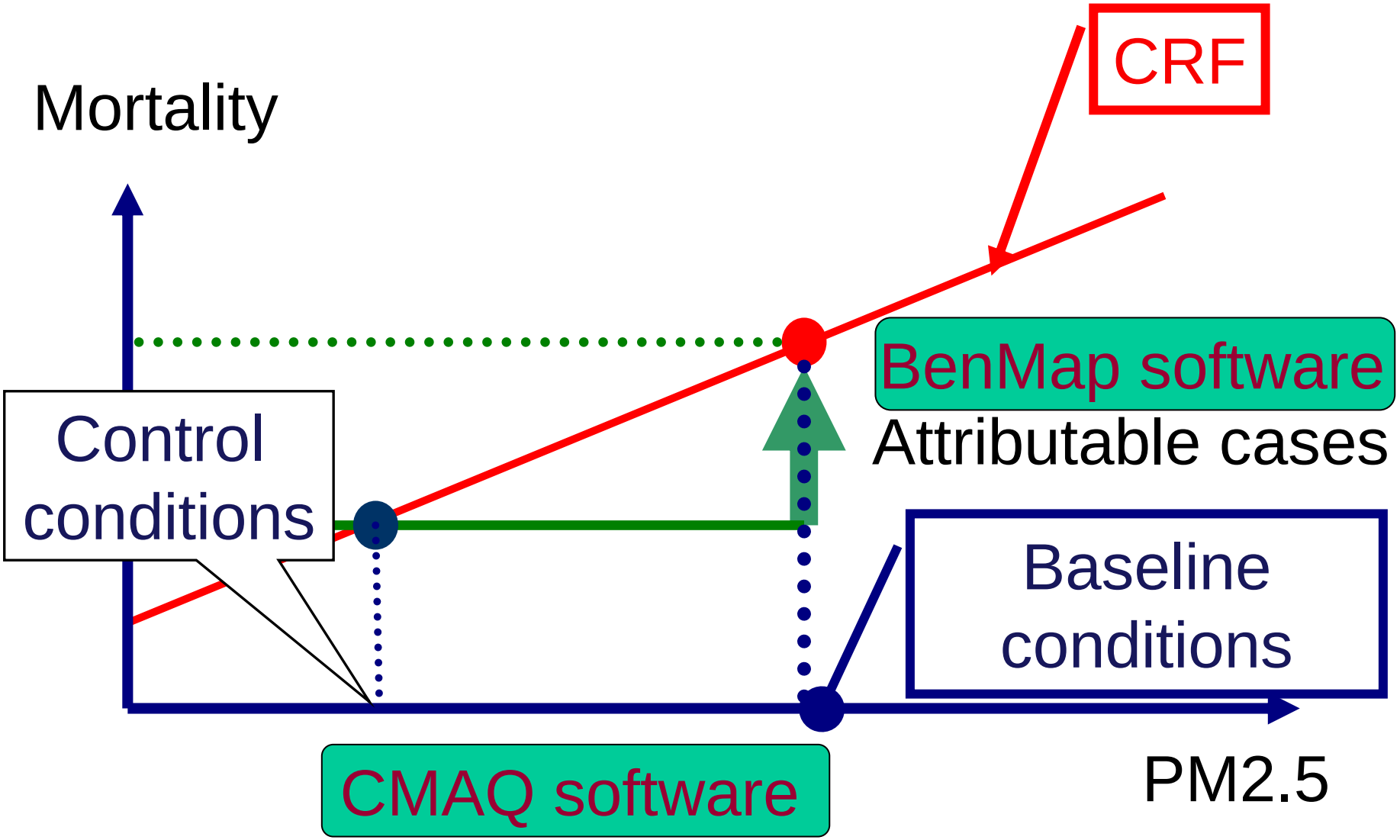
  Positive associations between exposure to air pollutants at low concentrations (particularly PM2.5) and adverse health outcomes

- **Objective**

  To estimate the number of avoidable deaths associated with reducing PM2.5 levels in Spain

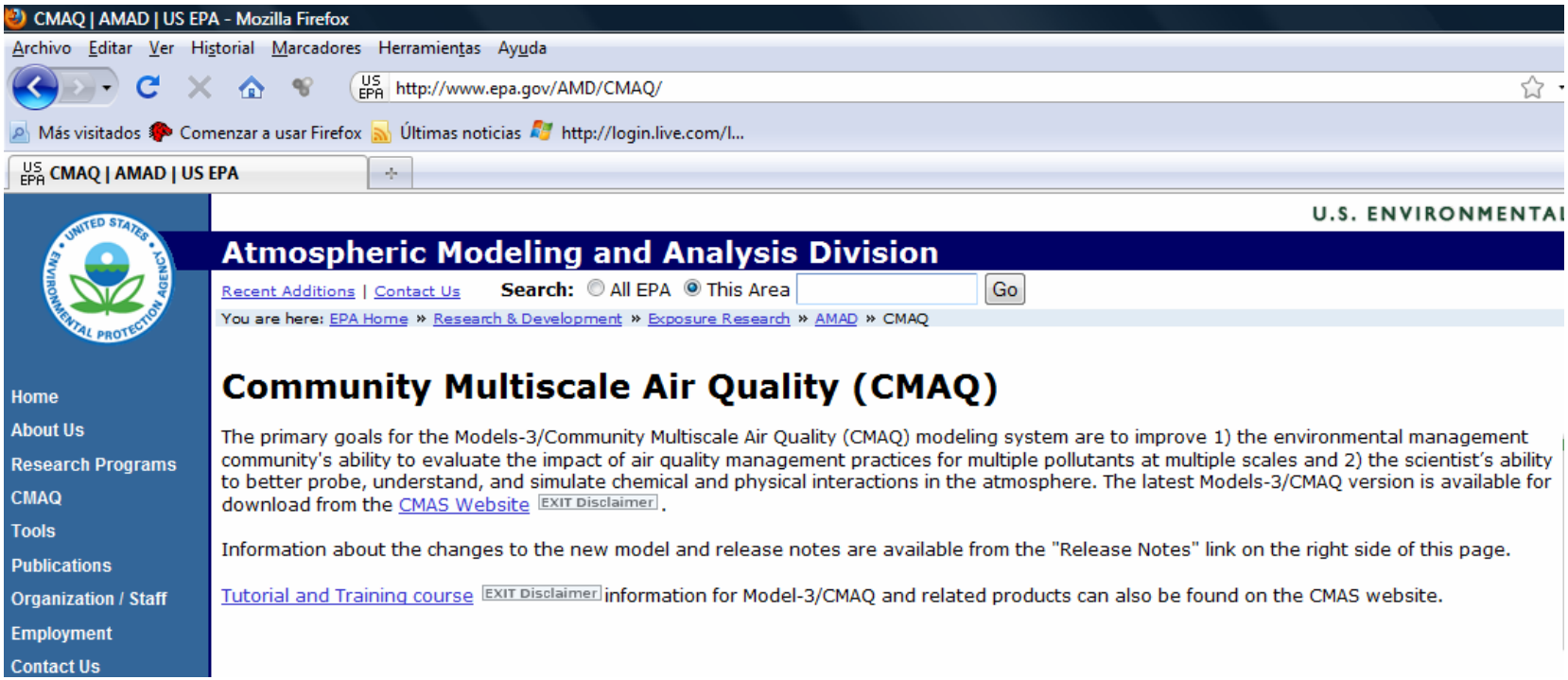
HIA methodology

Adapted from *Künzli, Kaiser, Medina et al,* ***Lancet 2000; 356: 795 - 801***



Methodology: Air Quality Change

- Air quality model tool: **CMAQ** (Community Multiscale Air Quality)
- Free software to provide baseline and control conditions (US EPA)

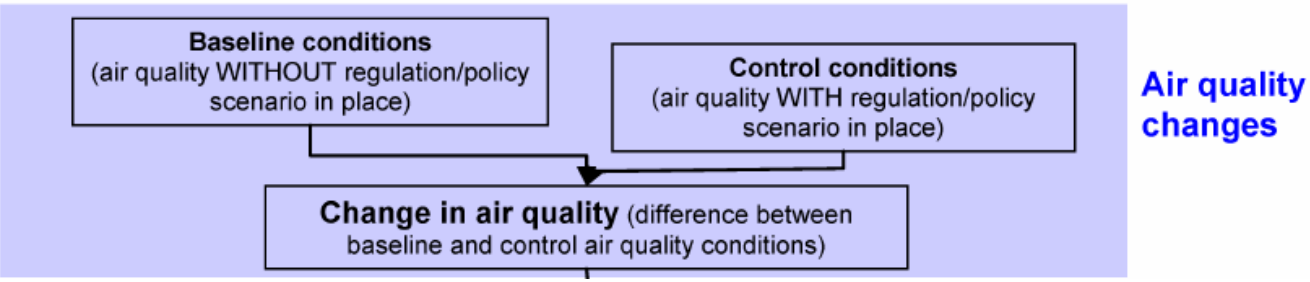


Methodology: Air Quality Change

Air quality modeling data:

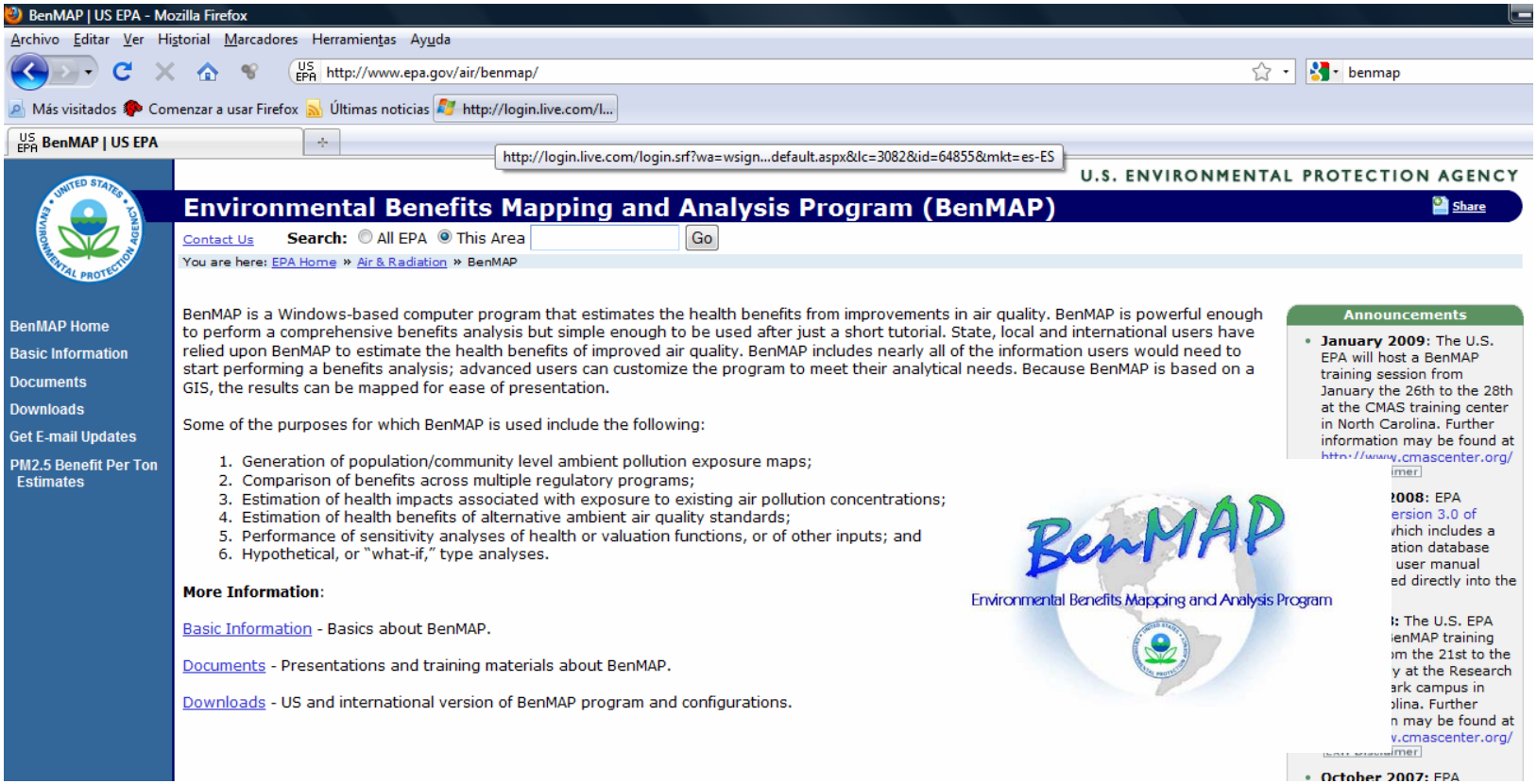
- **Baseline conditions**: a baseline 2004 scenario based on Spain's National Emissions Inventory

- **Control conditions**: a projected 2011 scenario in which a reduction in PM2.5 was estimated if specific air quality policies were implemented



Methodology: HIA tool

- **BenMAP** (Environmental Benefits Mapping and Analysis Program)
- Free software to estimate health benefits from improvements in air quality (US EPA)



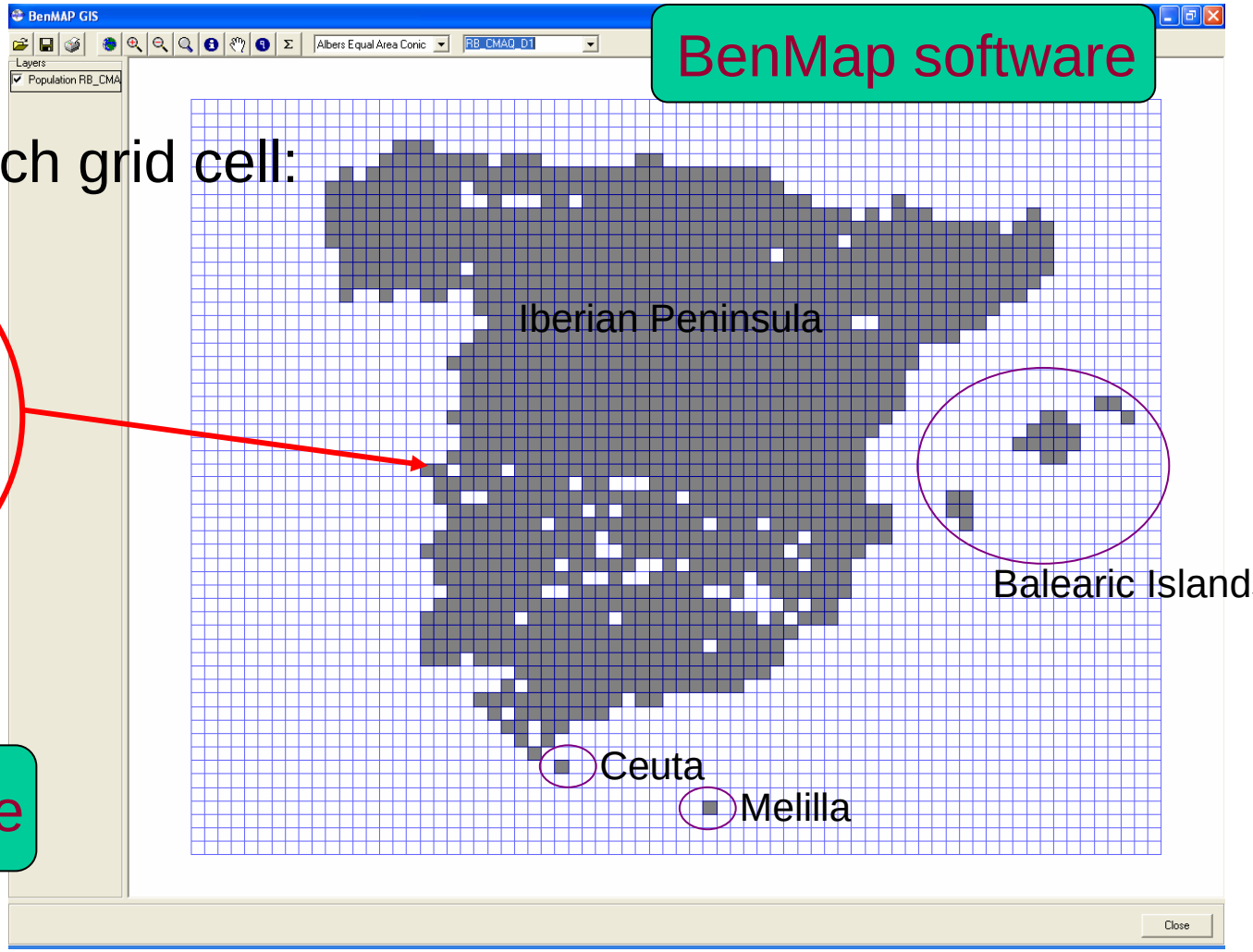
Methodology: Air Quality Change

Gridded information with 18 Km^2 spatial resolution

Input data for each grid cell:

1 baseline data
+
1 control data

CMAQ software



BenMap software

Linking air quality modelling and human impact assessment through the BenMAP

Methodology: Health effects (mortality)

- Spanish National Statistics Institute (INE) provided population and mortality data for each town (8,109 municipal cores)

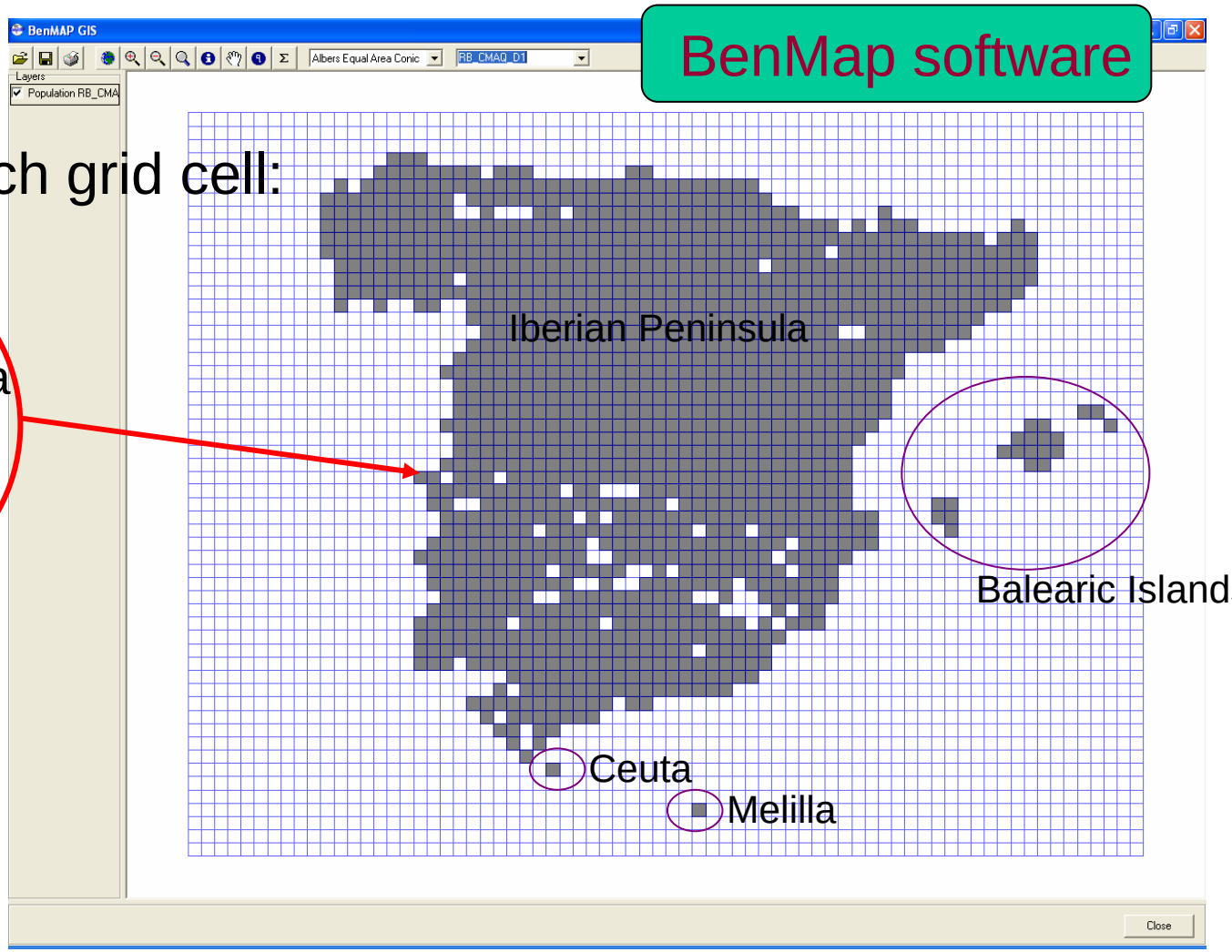
- 2004-2006 Crude all-cause **mortality** rates (ICD-10: A00-Y98) for the over-30 and 25-74 age groups

- 2004 **population** figures corresponding to these same age groups

Methodology: Mortality rate and population

Input data for each grid cell:

1 mortality rate data
+
1 population data



BenMap software

Methodology: CRF

- We used two CRFs linked to PM2.5 exposure (Laden et al., 2006; Pope et al., 2002)

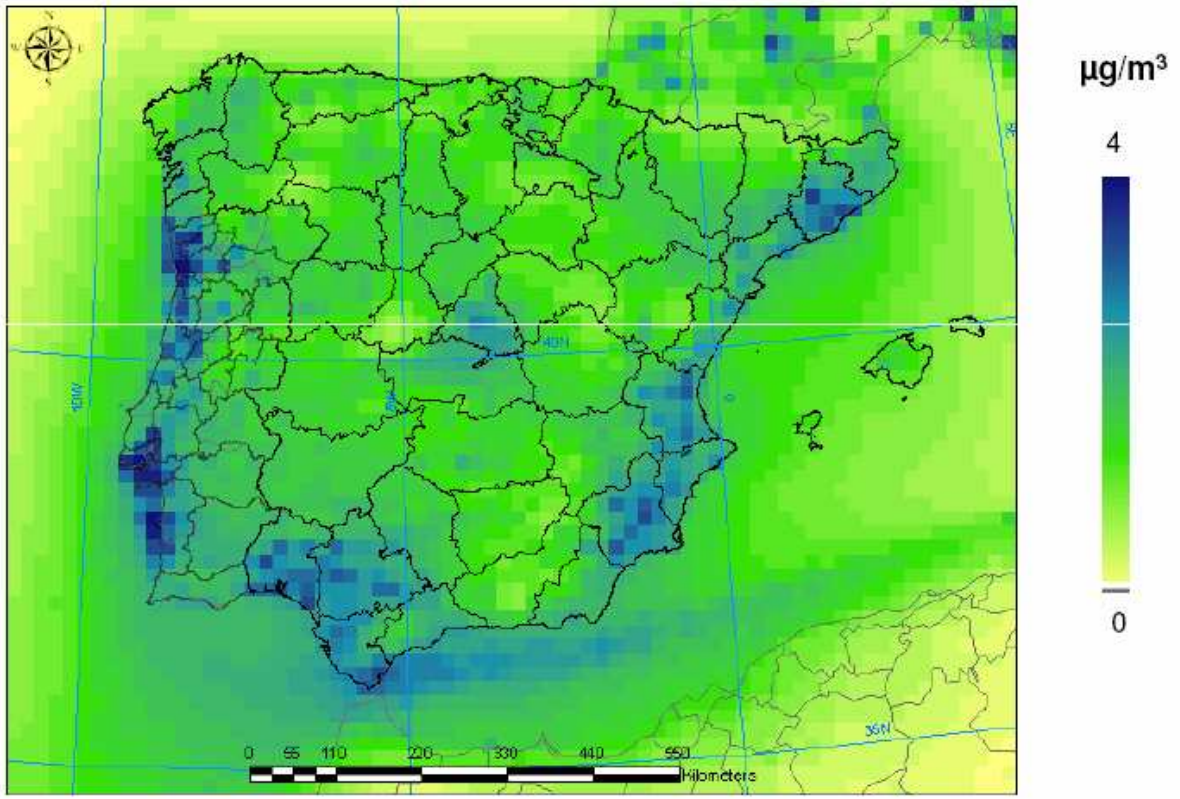
Study features			Regression coefficient (β)		
Author	Location	Study population (age groups)	Mean estimate	Std. Error	β distribution
Pope et al., 2002	51 US cities	500,000 (30-99 years)	$5.8*10^{-3}$	$2.1*10^{-3}$	Normal
Laden et al., 2006	6 US cities	8,096 (25-74 years)	$14.8*10^{-3}$	$4.1*10^{-3}$	Normal

Pope CA 3rd, Burnett RT, Thun MJ, Calle EE, Krewski D, Ito K et al. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. JAMA 2002; 287:1132-41

Laden F, Schwartz J, Speizer FE, Dockery DW. Reduction in fine particulate air pollution and mortality: extended follow-up of the Harvard Six Cities study. Am J Respir Crit Care Med 2006; 173:667-72

Results: Air Quality Change

Modeled PM2.5 change between baseline scenario (2004) and control scenario (2011)



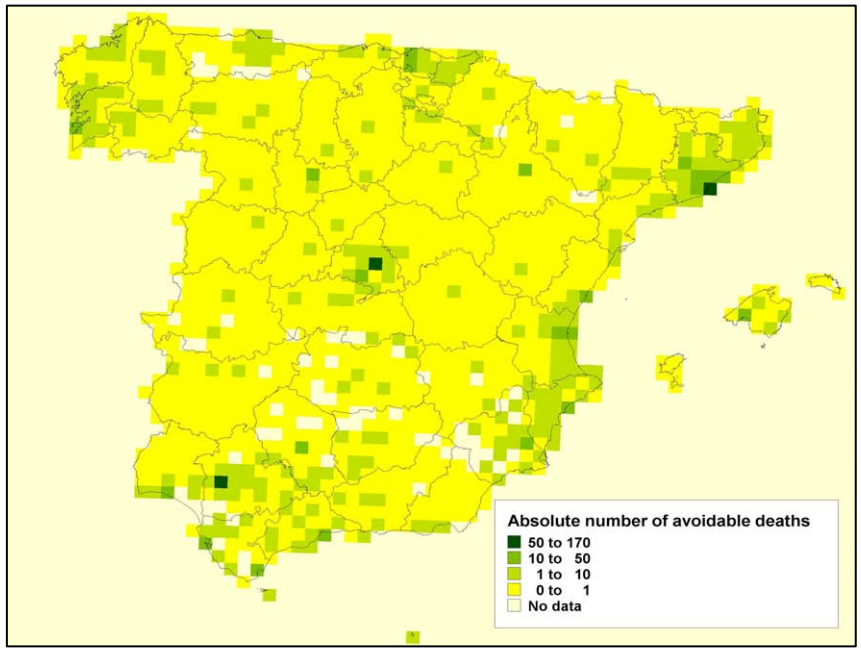
Air quality improvement was defined as an average annual reduction of 0.7 mg/m3 in PM2.5 levels

Results: assessing the health impacts

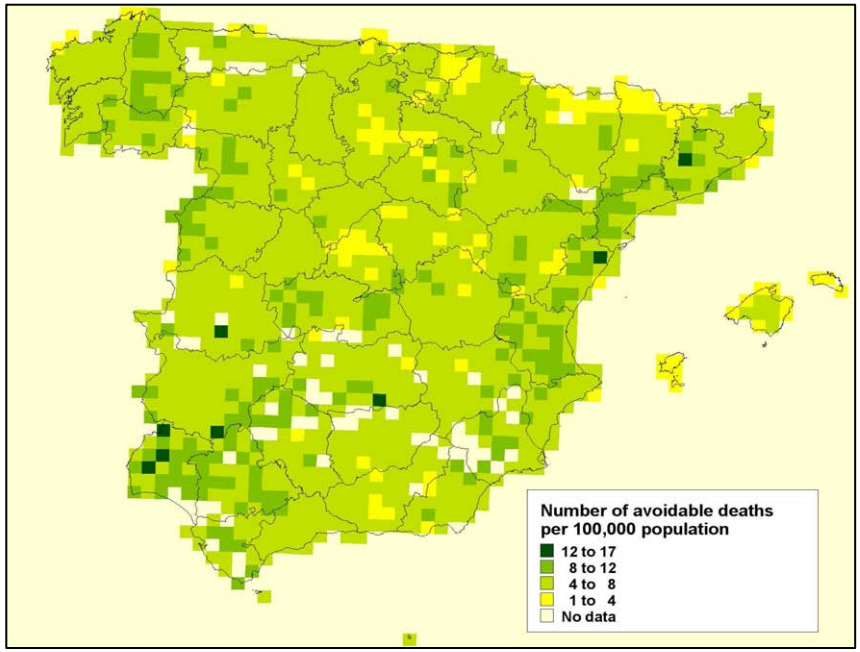
PM2.5: LONG-TERM HEALTH IMPACT ON ALL CAUSES MORTALITY IN SPAIN (SCENARIO 2004-2011)

HIA estimations according to Pope et al., 2002

Absolute number of annual avoidable deaths



Crude rates of avoidable deaths/ 100,000 population



Number of annual avoided premature deaths attributable to PM2.5 (µg/m3) in Spain. Concentration response function corresponding to Pope (2002). ICD-10: A00-Y98. Age group: 30-99. Air quality baseline scenario: 2004 year; air quality control scenario: 2011 year.

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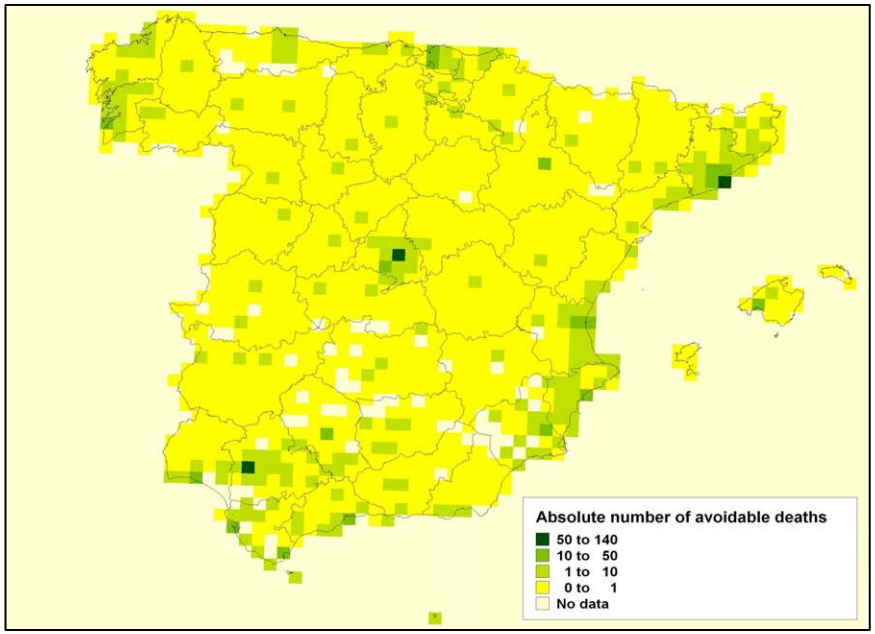

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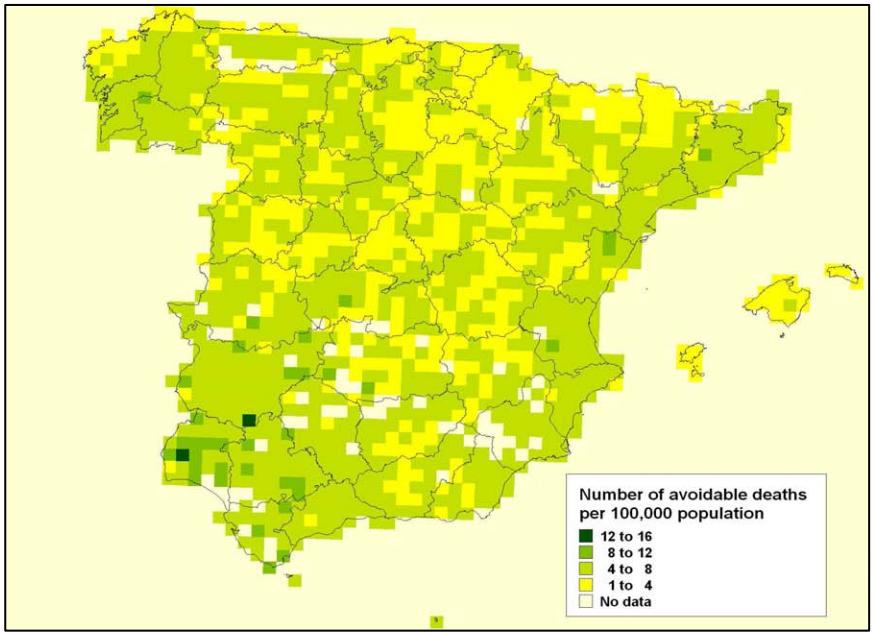

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Results: assessing the health impacts

Summary of long-term HIA findings in terms of potential reductions in the number of attributable deaths and rates per 100,000 population

Exposure indicator	Health indicator	Population at risk (age group)	CRF	Number of avoidable deaths (50^{th} percentile)	Range of avoidable deaths (5^{th}–95^{th} percentiles)	Number of avoidable deaths per 100,000
Long-term $PM_{2.5}$	All-cause mortality	27,327,894 (30-99 years)	Pope, 2002	1,718	673-2,760	6
		27,581,475 (25-74 years)	Laden, 2006	1,447	780-2,108	5

1,718 all-cause deaths (6 per 100,000 population) in the over-30 age group and 1,447 all-cause deaths (5 per 100,000 population) in the 25-74 age group could be prevented annually

Discussion

- The validity of HIA estimates depends on:
  - Quality of population and health data
  - Quality of exposure data
  - Risk estimates

- Our overall results are consistent with previous HIA studies undertaken in Europe and Spain

- BenMAP could be a suitable tool for future HIA in Spain and in other European countries

Summary

- Potential benefits in mortality if pollution control policies were successfully implemented by 2011
- First attempt to perform a national HIA of air pollution in Spain

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